FORM PTO-1390 (REV 10-94) — U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 9320.116USWO

US APPLICATION NO (If known, see 37 CFR 1.5): Unknown 09/743972

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FR99/01924	August 3, 1999	August 3, 1998

TITLE OF INVENTION

SELECTIVE MESH REFINEMENT

APPLICANT(S) FOR DO/EO/US

GIOIA

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [X] An unsigned oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
    [ ] A SECOND of SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information: International Preliminary Examination Report; International Search Report; 1449 and cited references; front page of PCT application

U.S. APPLICATION NO. (If known, see 37 C F R 1 5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
Unknown 09/743972	PCT/FR99/01924	9320.116USWO

17. [X] The following fees are submitted:

	CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492(a) (1)-(5)):		
Search Report has been prepared by the EPO or JPO **$860.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.492(a)(1)) **$720.00**		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) **$790.00**		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(3)) paid to USPTO **$1,000.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) **$98.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	**$0**	

CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE		
Total claims	8	-20 =	0	X **$18.00**	**$0**	
Independent claims	1	-3 =	0	X **$80.00**	**$0**	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+ **$260.00**	**$0**	
TOTAL OF ABOVE CALCULATIONS =					**$860.00**	
Reduction by 1/2 for filing by small entity, if applicable. Small entity status is claimed pursuant to 37 CFR 1.27					**$0**	
SUBTOTAL =					**$860.00**	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f).				+	**$0**	
TOTAL NATIONAL FEE =					**$860.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property				+	**$0**	
TOTAL FEES ENCLOSED =					**$860.00**	
					Amount to be: refunded	**$0**
					charged	**$0**

a. [X] Check(s) in the amount of $860.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 13-2725.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO
John J. Gresens
MERCHANT & GOULD
P.O. Box 2903
Minneapolis, MN 55402-0903

SIGNATURE 

John J. Gresens
NAME

33,112
REGISTRATION NUMBER

09/743972

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: GIOIA
Docket: 9320.116USWO
Title: SELECTIVE MESH REFINEMENT

JC06 Rec'd PCT/PTO 17 JAN 2001

CERTIFICATE UNDER 37 CFR 1.10
'Express Mail' mailing label number: EL658339301US
Date of Deposit: January 17, 2001
I hereby certify that this paper or fee is being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1.10 and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

By: _____
Name: Brant Miles

BOX PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

We are transmitting herewith the attached:

- ☒ Transmittal sheet, in duplicate, containing Certificate under 37 CFR 1.10.
- ☒ National Stage PCT Patent Application: Spec. 11 pgs; 8 claims; Abstract 1 pg. The fee has been calculated as shown below in the 'Claims as Filed' table.
- ☒ 2 sheets of formal drawings
- ☒ An unsigned Combined Declaration and Power of Attorney
- ☒ A check in the amount of $860.00 to cover the Filing Fee
- ☒ Other: PTO-1390; Preliminary Amendment; International Preliminary Examination Report; International Search Report; Front page of PCT application;
- ☒ Return postcard

CLAIMS AS FILED

Number of Claims Filed		In Excess of:		Number Extra		Rate		Fee
Basic Filing Fee								$860.00
Total Claims								
8	-	20	=	0	x	18.00	=	$0.00
Independent Claims								
1	-	3	=	0	x	80.00	=	$0.00
MULTIPLE DEPENDENT CLAIM FEE								$0.00
TOTAL FILING FEE								$860.00

Please charge any additional fees or credit overpayment to Deposit Account No. 13-2725. A duplicate of this sheet is enclosed.

MERCHANT & GOULD P.C.
P.O. Box 2903, Minneapolis, MN 55402-0903
(612) 332-5300

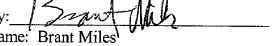
By: _____
Name: John J. Gresens
Reg. No.: 33,112
Initials: JJG/tvm

23552
PATENT TRADEMARK OFFICE

S/N unknown PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	GIOIA	Docket No.:	9320.116USWO
Serial No.:	unknown	Filed:	concurrent herewith
Int'l Appln No.:	PCT/FR99/01924	Int'l Filing Date:	August 3, 1999
Title:	SELECTIVE MESH REFINEMENT		

CERTIFICATE UNDER 37 CFR 1.10
'Express Mail' mailing label number: EL658339301US
Date of Deposit: January 17, 2001
I hereby certify that this correspondence is being deposited with the United States Postal Service 'Express Mail Post Office To Addressee' service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.
By: 
Name: Brant Miles

PRELIMINARY AMENDMENT

Box PCT
Assistant Commissioner for Patents
Washington, D. C. 20231

Dear Sir:

In connection with the above-identified application filed herewith, please enter the following preliminary amendment (marked-up copy attached):

IN THE ABSTRACT

Insert the attached Abstract page into the application as the last page thereof.

IN THE SPECIFICATION

A courtesy copy of the present specification is enclosed herewith. However, the World Intellectual Property Office (WIPO) copy should be relied upon if it is already in the U.S. Patent Office.

IN THE CLAIMS

Please amend the following claims:

3. (Amended) Encoding method according to claim 1, characterized in that it enables access to several levels of encoding quality, corresponding to each of said successive meshes.

4. (Amended) Encoding method according to claim 1, characterized in that said successive meshes are obtained by the implementation of a recursive algorithm.

5. (Amended) Encoding method according to claim 1, characterized in that said recursive algorithm comprises the following steps:

(a) the reception (31) of a wavelet coefficient indexed by a vertex (s) of barycentric coordinates (α,β,γ) on a face F_0;

(b) for each neighboring face F_j of F_0 containing said vertices (s):

- $F = F_i$ is supposed;
- from the barycentric coordinates (α,β,γ), the coordinates of said vertex (s) in the refined base (42) formed by the vertices of the face F, also referenced (α,β,γ) are deduced;
- if the coordinates α, β or γ are positive or zero and if two of them are strictly positive (43):
  - the face F (45) is subdived;
  - the processing of the step (b) is resumed for the four offspring of the face F successively

8. (Amended) Application of the encoding method according to claim 1 to at least one of the following fields:

- the display of meshed objects in a 3D screen;
- the progressive display of meshed objects in three dimensions on a screen, said wavelet coefficients being taken into account as and when they arrive;
- the display of meshed objects in three dimensions on a screen with at least two levels of detail, one level of detail corresponding to one of said successive meshes (M_i);
- the display of different parts of a meshed object with at least two different levels of detail;
- the compression of a mesh of a meshed object.

REMARKS

The above preliminary amendment is made to remove multiple dependencies from claims 3, 4, 5 and 8.

A new abstract page is supplied to conform to that appearing on the publication page of the WIPO application, but the new Abstract is typed on a separate page as required by U.S. practice.

Applicants respectfully request that the preliminary amendment described herein be entered into the record prior to calculation of the filing fee and prior to examination and consideration of the above-identified application.

If a telephone conference would be helpful in resolving any issues concerning this communication, please contact Applicants' primary attorney-of record, John J. Gresens (Reg. No. 33,112), at (612) 371.5265.

Respectfully submitted,

MERCHANT & GOULD P.C.
P.O. Box 2903
Minneapolis, Minnesota 55402-0903
(612) 332-5300

Dated: January 17, 2001

By _____
John J. Gresens
Reg. No. 33,112

JJG/tvm

ABSTRACT

Title: SELECTIVE MESH REFINEMENT

The invention concerns a method for coding an original mesh representing a three-dimensional object, which consist in determining a simple meshing having a reduced number of defined faces each defined by vertices and edges, then coefficients in a wavelet base of a function whereof said source mesh is the image defined on said simple mesh, so as to supply successive refined meshes. The method is characterized in that each of the faces of said meshes is subdivided into a limited number of facets to form the higher level mesh, the subdivisions of said surface corresponding only to those required for observing an affinity condition of said function of said face. The invention also concerns the corresponding method for reconstructing the mesh.

Marked-up Copy

--CLAIM 1--

3. Encoding method according to [one of the claims 1 and 2], characterized in that it enables access to several levels of encoding quality, corresponding to each of said successive meshes.

--CLAIM 1--

4. Encoding method according to [any of the claims 1 to 3] characterized in that said successive meshes are obtained by the implementation of a recursive algorithm.

--CLAIM 1--

5. Encoding method according to [any of the claims 1 to 4] characterized in that said recursive algorithm comprises the following steps:

(a) the reception (31) of a wavelet coefficient indexed by a vertex (s) of barycentric coordinates (α,β,γ) on a face F_0;

(b) for each neighboring face F_j of F_0 containing said vertices (s):

- $F = F_i$ is supposed;
- from the barycentric coordinates (α,β,γ), the coordinates of said vertex (s) in the refined base (42) formed by the vertices of the face F, also referenced (α,β,γ) are deduced;
- if the coordinates α, β or γ are positive or zero and if two of them are strictly positive (43):
  - the face F (45) is subdived;
  - the processing of the step (b) is resumed for the four offspring of the face F successively

--CLAIM 1--

8. Application of the encoding method according to [any of the claims 1 to 5] to at least one of the following fields:

- the display of meshed objects in a 3D screen;
- the progressive display of meshed objects in three dimensions on a screen, said wavelet coefficients being taken into account as and when they arrive;
- the display of meshed objects in three dimensions on a screen with at least two levels of detail, one level of detail corresponding to one of said successive meshes (M_i);
- the display of different parts of a meshed object with at least two different levels of detail;
- the compression of a mesh of a meshed object.

09/743972
528 Rec'd PCT/PTO 17 JAN 2001

SELECTIVE MESH REFINEMENT

The field of the invention is that of the encoding of images or image elements. More specifically, the invention relates to the adaptive representation and encoding of scenes (or objects of a scene) in three dimensions (3D) represented by meshes.

The invention can be applied in all fields where it is desirable to reduce the number of information elements needed for the efficient depiction, storage and/or transmission of a digital image. For example, the invention may be used to transmit images through the Internet. In this context, it enables the animation of 3D scenes with real-time display although the bit rate is neither constant nor ensured. In this case, the invention may be a primitive of a data transmission language such as VRML.

Other applications that may be envisaged include the storage of animated data on CD-ROM (or an equivalent data carrier), multiple-user applications, digital television, etc.

The invention proposes an improvement to so-called "wavelet" methods used to represent a mesh as a sequence of details added to a basic mesh. The general theory of this technique is described especially in the article by M. Lounsberry, T. DeRose and J. Warren, "Multiresolution analysis for surfaces of arbitrary topological type" (ACM Transaction on Graphics, Vol. 16, No. 1, pp. 34-73).

According to this technique, a mesh is therefore represented by a sequence of coefficients that correspond to the coordinates in a base of wavelets of a parametrization of said mesh by a simple polyhedron. The corresponding mathematical principles are recalled in the appendix (this appendix forms part of the present description).

In practice, during the reconstruction, the basic mesh M_0 is shown in tree form: each of its faces is the root of a tree for which the offspring of each node are the four faces obtained after canonical subdivision. The wavelet coefficients are indexed by their barycentric coordinates on one face of M_0.

A subdivision technique has been proposed by A. Certain, Jovan Popovic, T. DeRose, T. Duchamp, D. Salesin and W. Stuetzle in the article "Interactive Multiresolution Surface Viewing" (Computer Graphics Proceedings 1996).

This technique consists in making subdivisions by observing a sufficient condition on the vertices: a vertex is said to be full if it is in the middle of a ridge shared by two faces that are subdivided into four as shown in Figure 1.

The principle lies in starting from the vertex indexing the wavelet coefficient considered and, by subdivision, making its neighbors and then the neighbors of its neighbors complete, recursively until all the vertices are considered to be complete. This rule is derived from the observation that this algorithm is sufficient to provide for a subdivision adapted to the modifications made by the wavelet coefficient considered.

However, this technique has a major drawback: it induces the creation of unnecessary facets, leading to an unnecessary increase in the number of data elements necessary for the description of the mesh. More specifically, unnecessary facets are created by subdivisions that give the completeness of the vertices referred to further above.

In other words, there is a creation, in zones relatively distant from the support of the observed wavelet, of coplanar facets. This unnecessarily lowers the efficiency of the display of the object.

It is indeed known that the number of data elements (and therefore the number of facets) has major consequences especially when the object concerned is animated, the power of the terminal is limited and/or the transmission bit rate is variable and/or limited.

It is an aim of the invention especially to overcome these drawbacks of the prior art.

More specifically, it is an aim of the invention to provide a method for the encoding of a mesh representing a 3D object that produces a number of facets that is limited, as compared with the prior art, for an identical or similar quality of restitution.

Another aim of the invention is to provide an encoding method of this kind whose complexity (especially in terms of numbers of operations performed and memory capacity needed) is smaller, or at least of the same magnitude, as that of the known techniques.

It is also an aim of the invention to provide an encoding method of this kind, that can be used to have several levels of quality of restitution of the object, as a function of various criteria (processing capacity of the terminal, capacity of the available storage means, transmission bit rate, the user's needs, etc.).

Yet another aim of the invention is to provide an encoding method of this kind that can be used for a progressive reconstruction of the object.

It is also an aim of the invention, naturally, to provide a method of reconstruction of an object encoded according to this encoding method.

These aims and others that shall appear hereinafter are achieved according to the invention by means of a method for the encoding of a source mesh (M) representing a 3D object in which there is determined a simple mesh (M_0) with a limited number of faces, each defined by vertices and ridges, and then coefficients in a base of wavelets of a function (f), of which said source mesh is the image defined on said simple mesh (M_0), so as to give a subdivision of said source mesh (M) into successive refined meshes (or sub-meshes) (M_j), according to a predetermined criterion. According to the invention, each of the faces of said meshes (M_j) is subdivided into a limited number of facets to form the higher-level mesh (M_{j+1}), the subdivisions of said face corresponding solely to those needed to comply with a condition of affinity of said function (f) on said face.

Indeed, the inventor has observed that the taking into account of a wavelet coefficient must be accompanied by a local subdivision in the vicinity of the vertex indexing the wavelet in question, so that this wavelet can be refined by pieces on said facet. Since, the wavelets are the sums of functions ϕ_i^j, it is sufficient to be able to localize the support of such a function and locally subdivide the facets that contain them until this function is refined on each resultant facet.

It will be noted hereinafter that the terms "face" and "facet" are used without distinction. In general, a "facet" is a subdivision of a "face".

Advantageously, said souree mesh (M) is subdivided up into a set of trees, each of said trees representing a face of said simple mesh (M_0) and comprising nodes each representing a face of a mesh (M_j), said function (f) being refined on each of said faces. Then, each of said trees is the smallest such that, when a given face is subdivided into four faeets, the corresponding node comprises four offspring representing said four faeets.

Advantageously, the method of the invention enables access to several levels of encoding quality, corresponding to each of said successive meshes.

This is easy because of the very structure of the subdivision as shall be seen hereinafter.

Preferably, said successive meshes are obtained by the implementation of a recursive algorithm. The method is thus particularly simple to implement.

According to an advantageous embodiment, said recursive algorithm comprises the following steps:

(a) the reception of a wavelet coefficient indexed by a vertex (s) of barycentric coordinates (α, β, γ) on a face F_0;

(b) for each neighboring face F_j of F_0 containing said vertices (s):

- $F = F_i$ is supposed;
- from the barycentric coordinates (α, β, γ), the coordinates of said vertex (s) in the refined base formed by the vertices of the face F, also refereneed (α, β, γ), are deduced ;
- if the coordinates α, β or γ are positive or zero and if two of them are strictly positive:
  - the face F is subdivided;
  - the processing of the step (b) is resumed for the four offspring of the face F successively.

The invention also relates to a method of reconstruetion of a source mesh (M) representing a 3D objeet encoded according to the encoding method deseribed here above.

Advantageously, a method of reconstruction of this kind provides for the progressive reconstruction of said object using the simple mesh (M_0) and then by means of suceessive meshes (M_i).

Prefcrably, this method of reconstruetion enables aceess to several levels of quality of eneoding, eorresponding to eaeh of said suceessive meshes.

The invention can be applied advantageously to several fields and can be applied especially to at least one of the following fields:

- the display of meshed objects in a 3D screen;
- the progressive display of meshed objeets in three dimensions on a sereen, said wavelet coefficients being taken into account as and when they arrive;
- the display of meshed objects in three dimensions on a screen with at least two levels of detail, one level of detail corresponding to one of said successive meshes (M_i);
- the display of different parts of a meshed objeet with at least two different levels of detail;
- the compression of a mesh of a meshed object.

Other features and advantages of the invention shall appear more elearly from the following description of a preferred embodiment of the invention given by way of a simple non-restrictive illustration and from the appended drawings, of whieh:

- Figure 1, already commented upon in the introduetion, illustrates a eomplete vertex according to the tcehnique used by Certain et al.;

- Figure 2 illustrates the direct neighborhood of a vertex s aecording to the invention;

- Figure 3 is a simplified general block diagram of the encoding method according to the invention;

- Figure 4 is a more detailed block diagram, resuming and detailing the steps of localization and subdivision of Figure 3.

The method of encoding a mesh according to the invention is therefore aimed especially at carrying out the minimum number of subdivisions needed while at the same time retaining the same algorithmic complexity as in the prior art.

Throughout the rest of this document, it will be said that a point s has barycentric coordinates (α, β, γ), on a face F_0 if its barycentric coordinates in the refined base formed by the vertices of F_0 are (α, β, γ). Also, M_0 will not be specified when there is no possible confusion.

The basic algorithm of the invention, independently of any implementation, is the following:

1. Receive a wavelet coefficient indexed by a vertex s having barycentric coordinates (α, β, γ), on a face F_0.
2. For each neighboring face F_i of F_0 containing s:
   (a) $F = F_i$.
   (b) Deduce (α, β, γ) the coordinates of s in the refined base formed by the vertices of F also referenced (α, β, γ).
   (c) If α or β or γ are all positive or null or if two of them are strictly positive:
      i. subdivide F
      ii. start again at (b) with, for F, its four offspring successively.

When the algorithm stops, there is a minimum subdivision of M_0 obtained with a complexity in linear time as compared with the degree of subdivision. The transmission bit rate and/or the storage capacity needed are therefore optimized.

It must be noted that the invention is used to determine not only the minimum tree corresponding to f, but also each of its approximations, in truncating the sum (see appendix):

$$f = \sum_i c_i^0 \phi_i^0 + \sum_{j \geq 0} \sum_i d_i^j \psi_i^j$$

Since the sum is precisely obtained progressively, by adding terms one after the other, the operation passes from a tree representing an approximation f_i to a tree representing:

$$f_i + c_i^{j'} \psi_i^{j'}$$

(where $c^{j'}_i$ is a wavelet coefficient transmitted in performing only the facet subdivisions strictly necessary for the condition of affinity on each face.

It is thus possible to progressively reconstruct the object and/or to choose a level of quality (corresponding to the index j).

The progressively reconstructed mesh can be represented as n 4-trees describing the successive divisions of the n faces of the mesh M_0 transmitted prior to the wavelet coefficients. Each wavelet coefficient received is accompanied by three integers A, B and C proportional to the barycentric coordinates of the vertex s indexing the wavelet associated with the coefficient, as well as an integer designating the face F_0 indicating a facet containing s.

If s belongs to M_j+1, A, B and C are deduced from the barycentric coordinates α,β and γ of s in the refined base formed by the vertices of F_0 by:

$$(A, B, C) = 2^{j+1} (\alpha,\beta, \gamma)$$

The wavelet centered at s has the form:

$$\psi_i^j = \phi_i^{j+1} + \sum_{k \in D} \alpha_k \phi_k^j$$

where D is the neighborhood of s on the mesh M_j. The technique explained in the previous part must therefore be applied to each of the functions that appear in the sum, with their respective barycentric coordinates.

These barycentric coordinates are expressed in the same refined base as those of s and deduced from these coordinates: the neighborhood D is, for a value

of k that is fixed, the set of vertices of M_j at a distance of at most k ridges from one of the ends s_1 and s_2 of the ridge of M_j containing s, as shown in Figure 2. The barycentric coordinates of these two vertices are characterized by the following criterion:

The triplet $(\alpha', \beta', \gamma')$ represents the coordinates of one of these two points if and only if the triplet of integers $(A', B', C') = 2^j (\alpha', \beta', \gamma')$ verifies:

$$(2A' - A, 2B' - B, 2C' - C) \in \varepsilon$$

where ε designates the set:

$$\{(1, -1, 0), (-1, 1, 0), (1, 0, 1), (-1, 0, 1), (0, 1, -1), (0, -1, 1)\}$$

With these two direct neighbors of s, s_1 and s_2 being determined, the others are determined by applying the following criterion k times:

let u and v be two vertices with barycentric coordinates $(\alpha', \beta', \gamma')$ and $(\alpha'', \beta'', \gamma'')$ respectively on a face F. Then u and v are connected by a ridge on M_j if and only if:

$$2^j(\alpha' - \alpha'', \beta' - \beta'', \gamma' - \gamma'') \in \varepsilon$$

giving explicitly the list of the vertices in the neighborhood D.

Each of these vertices, provided with its barycentric coordinates $(\alpha, \in\beta, \gamma)$ may thus give rise to the subdivisions needed for the modifications made by the corresponding function ϕ^j, according to a variant of the algorithm described further above. The operation starts from the pair $(A, B, C) = 2^j (\alpha, \beta, \gamma)$ where j is the smallest integer such that A, B and C are integers and, at each subdivision, the basic change matrix of this triplet is applied in such a way that tests of positivity are made only on the integers.

The four matrices of passage of the refined base represented by the three vertices of a face with refined bases represented by the three vertices of each of the offspring are explicitly:

$$\begin{pmatrix} 1 & -1 & -1 \\ 0 & 2 & 0 \\ 0 & 1 & 2 \end{pmatrix}, \begin{pmatrix} 2 & 0 & 0 \\ -1 & 1 & -1 \\ 0 & 0 & 2 \end{pmatrix}, \begin{pmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ -1 & -1 & 1 \end{pmatrix} \text{ et } \begin{pmatrix} 1 & 1 & -1 \\ -1 & 1 & 1 \\ 1 & -1 & 1 \end{pmatrix}$$

The method described herc above is illustrated in a very simplified way in Figure 3. For each wavelct coefficient D^j_i received (31), a localization step 32 is performed in which the elements to be processed are brought into the appropriate refined base and then a step of subdivision (33) of each face considered is performed.

A more detailed exemplary implementation of these two steps 32 and 33 is shown in Figure 4.

In the localization 32, with ψ^j_i being written as a weighted sum of scale functions at the level j+1, the faces and the barycentric coordinates of the points of M_0 (or vertices of M_j) indexing these scale funetions are determined.

Then, for each triplet with coordinates (α, β, γ) associated with a face F (41), the coordinates (α', β', γ') corresponding to (α, β, γ) in thc base of the vertices of F are computed (42) and (α, β, γ) = (α', β', γ') is supposed.

Thcn the test 43 is performed:

($\alpha \geq 0$) and ($\beta \geq 0$) and ($\gamma \geq 0$) and (($\alpha\ \beta > 0$) or ($\alpha\ \gamma > 0$) or ($\beta\ \gamma > 0$))

If the result is positive (44), a recursivity loop is made in which the face F is subdivided (45) into four offspring F_i and then for each offspring F_i (46) $F = F_i$ (47) is supposed and the operation is resumed at the step 41 recursively.

If the result of the test 43 is negative, thc processing is resumed (48) for a new face F (41). When all the faces F have becn processed, the subdivision is ended (49).

APPENDIX

A surface S in the space may be represented as the image of a continuous injective function defined on a polyhedron M_0 of the topological type with values in $\mathbf{R}^3$. It is said then that the surface is parametrized by the polyhedron, and it is called the parametrization of said function. This function is a triplet of functions whose values in **R**, each of which may each be developed in a base of the space $C^0(M_0)$ of the continuous functions on the polyhedrons with values in **R**.

In the case of the meshed surfaces, this technique is used to obtain a compressed mesh representation. Furthermore, the use of wavelets as a basic function provides for a progressive representation thereof from the roughest form to the most detailed form.

These function are not wavelets in the standard sense but are in accordance with refining relationships that generalize the concept of multiple resolution analysis. Let M_0 denote a polyhedron on which a parametrization of a surface M is defined. We consider the subspace S_0 of $C^0(M_0)$ generated by the functions ϕ_i^0 defined as follows: ϕ_i is refined on each facet, equals 1 on the i-th vertex and equals 0 on all the other vertices.

The subspaces S_j engendered by the functions ϕ_i^j are defined in the same way but in replacing M_0 by the mesh M_j obtained by canonically subdividing each facet of M_{j-1}. The spaces S_j are finite in dimension and nested, S_0 being the smallest and every continuous function of M_0 in **R** can be approached uniformly by a function of an S_j for j as a fairly large number.

It is this inclusion that enables the progressive encoding: if W_j is taken to denote an additional value of S_j and S_{j+1} and $\{\psi_i^j\}^i$ (the wavelets) a basc of W_j, the set

$$\{\phi_i^0\}_i \cup \bigcup_{j\geq 0} \{\psi_i^j\}_i$$

forms a base of $C^0(M_0)$. The function ρ parametrizing M is written therefore in a unique way:

$$\rho = \sum_i c_i \phi_i^0 + \sum_{j \geq 0} \sum_i d_i^j \psi_i^j,$$

where the values e_i and the values d_i^j are in $\mathbf{R}^3$, and are called wavelet coefficients.

In practice, the wavelets are chosen in such a way that their support enables a determining of the coefficients of wavelets at O(n) where n is the number of vertices of the mesh M: for k as a fixed integer, if $D_{k,i}$ is taken to denote the set of indices of the vertices of a mesh M_j which are at a distance of less than k ridges from the vertex i, the wavelet ψ_i^j is given by:

$$\psi_i^j = \phi_i^{j+1} + \sum_{l \in D_{k,i}} \alpha_l \phi_l^j,$$

in such a way that ψ_i^j is with a support in $D_{k+1,i}$.

Thus, during the reconstruction, the influence of a wavelet coefficient is limited to a neighborhood of this kind.

CLAIMS :

1. Method for the encoding of a source mesh (M) representing a 3D object in which there is determined a simple mesh (M_0) with a limited number of faces, each defined by vertices and ridges, and then coefficients in a base of wavelets of a function (f) of which said source mesh is the image defined on said simple mesh (M_0), so as to give a subdivision of said source mesh (M) into successive refined meshes (or sub-meshes) (M_j), according to a predetermined criterion.
characterized in that each of the faces of said meshes (M_j) is subdivided into a limited number of facets to form the higher-level mesh (M_{j+1}), the subdivisions of said face corresponding solely to those needed to comply with a condition of affinity of said function (f) on said face.

2. Encoding method according to claim 1, characterized in that said source mesh (M) is subdivided up into a set of trees, each of said trees representing a face of said simple mesh (M_0) and comprising nodes each representing a face of a mesh (M_j), said function (f) being refined on each of said faces
and each of said trees being the smallest such that, when a given face is subdivided into four facets, the corresponding node comprises four offspring representing said four facets.

3. Encoding method according to one of the claims 1 and 2, characterized in that it enables access to several levels of encoding quality, corresponding to each of said successive meshes.

4. Encoding method according to any of the claims 1 to 3, characterized in that said successive meshes are obtained by the implementation of a recursive algorithm.

5. Encoding method according to any of the claims 1 to 4, characterized in that said recursive algorithm comprises the following steps:

(a) the reception (31) of a wavelet coefficient indexed by a vertex (s) of barycentric coordinates (α,β,γ) on a face F_0;

(b) for each neighboring face F_j of F_0 containing said vertices (s):

- $F = F_i$ is supposed;
- from the barycentric coordinates (α,β,γ), the coordinates of said vertex (s) in the refined base (42) formed by the vertices of the face F, also referenced (α,β,γ) are dedueed;
- if the coordinates α, β or γ are positive or zero and if two of them are strictly positive (43):
  - the face F (45) is subdivided;
  - the proeessing of the step (b) is resumed for the four offspring of the face F successively.

6. Method of reconstruction of a source mesh (M) representing a 3D object encoded according to the encoding method of claim 1, characterized in that said object is reconstructed progressivcly, using the simple mesh (M_0), and then by means of successive meshes (M_i).

7. Method of reconstruction according to claim 6, characterized in that it enables access to several levels of quality of encoding, corresponding to each of said successive meshes.

8. Application of the encoding method according to any of the claims 1 to 5 to at least one of the following fields:

- the display of meshed objects in a 3D screen;
- the progressive display of meshed objects in three dimensions on a screen, said wavelet coefficients being taken into account as and when they arrive;
- the display of meshed objects in three dimensions on a screen with at least two levels of detail, one level of detail corresponding to one of said successive meshes (M_i);
- the display of different parts of a meshed object with at least two different levels of detail;
- the compression of a mesh of a meshed object.

LEGENDES DES DESSINS

Figure 3 ;

31. Reception of a wavelet coefficient d_i

32. Localization

33. Subdivision

Figure 4

Reprendre les légendes telles que traduites par le WPO sauf la référence 33 : remplacer « peak » par « vertex ».

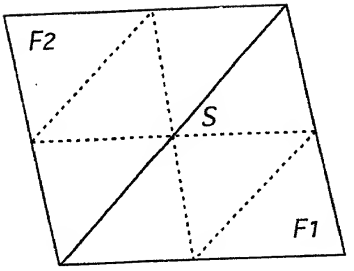


Fig. 1

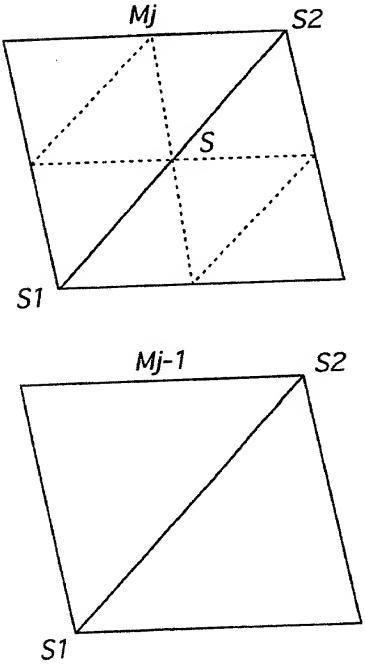


Fig. 2

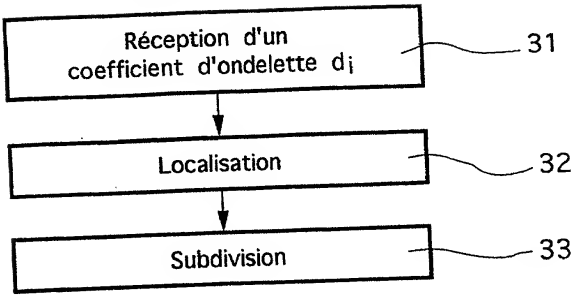

Réception d'un coefficient d'ondelette d_i
31
Localisation
32
Subdivision
33

Fig. 3

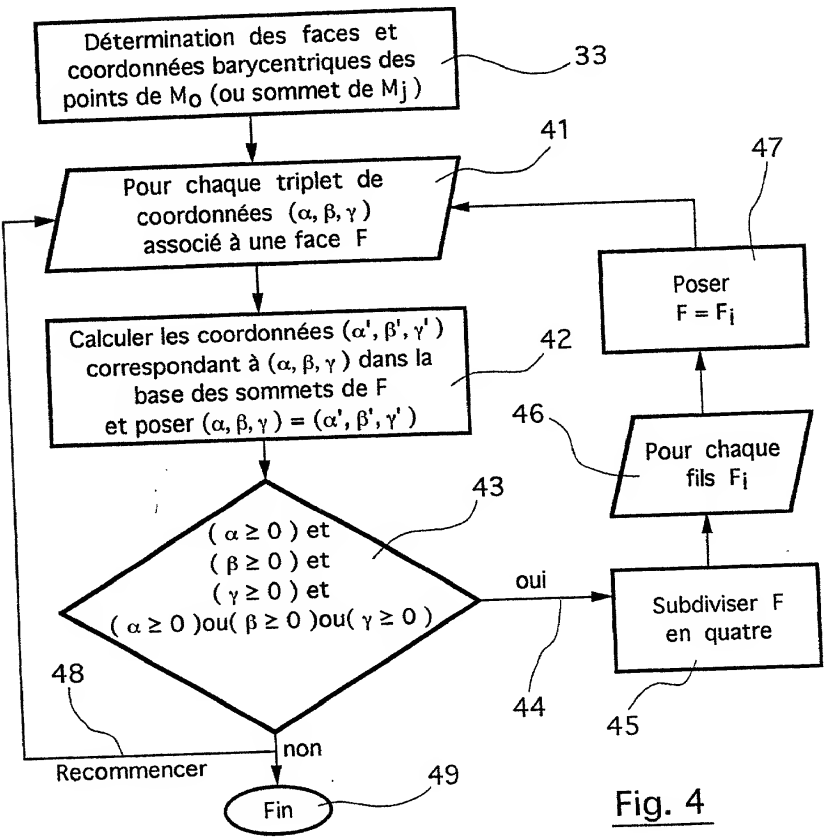
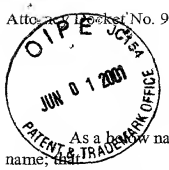

Détermination des faces et coordonnées barycentriques des points de M_0 (ou sommet de M_j)
33
Pour chaque triplet de coordonnées (α, β, γ) associé à une face F
41
Calculer les coordonnées $(\alpha', \beta', \gamma')$ correspondant à (α, β, γ) dans la base des sommets de F et poser $(\alpha, \beta, \gamma) = (\alpha', \beta', \gamma')$
42
$(\alpha \geq 0)$ et $(\beta \geq 0)$ et $(\gamma \geq 0)$ et $(\alpha \geq 0)$ ou $(\beta \geq 0)$ ou $(\gamma \geq 0)$
43
oui
Subdiviser F en quatre
44
45
Pour chaque fils F_i
46
Poser $F = F_i$
47
non
48
Recommencer
Fin
49

Fig. 4

Atto[illegible] Docket No. 9320.116USWO



MERCHANT & GOULD P.C.

United States Patent Application

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: SELECTIVE MESH REFINEMENT

The specification of which
a. ☐ is attached hereto
b. ☒ was filed on January 17, 2001 as application serial no. and was amended on (if applicable) (in the case of a PCT-filed application) described and claimed in international no. PCT/FR99/01924 filed August 3, 1999 and as amended on (if any), which I have reviewed and for which I solicit a United States patent.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on the basis of which priority is claimed:

a. ☐ no such applications have been filed.
b. ☒ such applications have been filed as follows:

FOREIGN APPLICATION(S), IF ANY, CLAIMING PRIORITY UNDER 35 USC § 119			
COUNTRY	**APPLICATION NUMBER**	**DATE OF FILING (day, month, year)**	**DATE OF ISSUE (day, month, year)**
France	98 10097	August 3, 1998	
ALL FOREIGN APPLICATION(S), IF ANY, FILED BEFORE THE PRIORITY APPLICATION(S)			
COUNTRY	**APPLICATION NUMBER**	**DATE OF FILING (day, month, year)**	**DATE OF ISSUE (day, month, year)**

I hereby claim the benefit under Title 35, United States Code, § 120/365 of any United States and PCT international application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. APPLICATION NUMBER	**DATE OF FILING (day, month, year)**	**STATUS (patented, pending, abandoned)**

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below:

U.S. PROVISIONAL APPLICATION NUMBER	**DATE OF FILING** (Day, Month, Year)

I acknowledge the duty to disclose information that is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56 (reprinted below):

§ 1.56 Duty to disclose information material to patentability.

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application:

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

(e) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

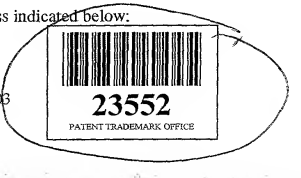
I hereby appoint the following attorney(s) and/or patent agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith:

Albrecht, John W.	Reg. No. 40,481	Leon, Andrew J.	Reg. No. 46,869
Ali, M. Jeffer	Reg. No. 46,359	Leonard, Christopher J.	Reg. No. 41,940
Anderson, Gregg I.	Reg. No. 28,828	Liepa, Mara E.	Reg. No. 40,066
Batzli, Brian H.	Reg. No. 32,960	Lindquist, Timothy A.	Reg. No. 40,701
Beard, John L.	Reg. No. 27,612	Lycke, Lawrence E.	Reg. No. 38,540
Berns, John M.	Reg. No. 43,496	Mayfield, Denise L.	Reg. No. 33,732
Black, Bruce E.	Reg. No. 41,622	McDonald, Daniel W.	Reg. No. 32,044
Branch, John W.	Reg. No. 41,633	McIntyre, Jr., William F.	Reg. No. 44,921
Bremer, Dennis C.	Reg. No. 40,528	Mitchem, M. Todd	Reg. No. 40,731
Bruess, Steven C.	Reg. No. 34,130	Mueller, Douglas P.	Reg. No. 30,300
Byrne, Linda M.	Reg. No. 32,404	Nichols, A. Shane	Reg. No. 43,836
Campbell, Keith	Reg. No.P-46,597	Pauly, Daniel M.	Reg. No. 40,123
Carlson, Alan G.	Reg. No. 25,959	Phillips, Bryan K.	Reg. No. P-46,990
Caspers, Philip P.	Reg. No. 33,227	Phillips, John B.	Reg. No. 37,206
Chiapetta, James R.	Reg. No. 39,634	Prendergast, Paul	Reg. No. 46,068
Clifford, John A.	Reg. No. 30,247	Pytel, Melissa J.	Reg. No. 41,512
Coldren, Richard J	Reg. No 44,084	Qualey, Terry	Reg. No. 25,148
Daignault, Ronald A.	Reg. No. 25,968	Reich, John C.	Reg. No. 37,703
Daley, Dennis R.	Reg. No. 34,994	Reiland, Earl D.	Reg. No. 25,767
Dalglish, Leslie E.	Reg. No. 40,579	Samuels, Lisa A.	Reg. No. 43,080
Daulton, Julie R.	Reg. No. 36,414	Schmaltz, David G.	Reg. No. 39,828
DeVries Smith, Katherine M.	Reg. No. 42,157	Schuman, Mark D.	Reg. No. 31,197
DiPietro, Mark J.	Reg. No. 28,707	Schumann, Michael D.	Reg. No. 30,422
Edell, Robert T.	Reg. No. 20,187	Scull, Timothy B.	Reg. No. 42,137
Epp Ryan, Sandra	Reg. No. 39,667	Sebald, Gregory A.	Reg. No. 33,280
Glance, Robert J.	Reg. No. 40,620	Skoog, Mark T.	Reg. No. 40,178
Goggin, Matthew J.	Reg. No. 44,125	Spellman, Steven J.	Reg. No. 45,124
Golia, Charles E.	Reg. No. 26,896	Stoll-DeBell, Kirstin L.	Reg. No. 43,164
Gorman, Alan G.	Reg. No. 38,472	Sumner, John P.	Reg. No. 29,114
Gould, John D.	Reg. No. 18,223	Swenson, Erik G.	Reg. No. 45,147
Gregson, Richard	Reg. No. 41,804	Tellekson, David K.	Reg. No. 32,314
Gresens, John J.	Reg. No. 33,112	Trembath, Jon R.	Reg. No. 38,344
Hamer, Samuel A.	Reg. No. 46,754	Tuchman, Ido	Reg. No. 45,924
Hamre, Curtis B.	Reg. No. 29,165	Tunheim, Marcia A	Reg. No. 42,189
Harrison, Kevin C.	Reg. No.P-46,759	Underhill, Albert L.	Reg. No. 27,403
Hertzberg, Brett A.	Reg. No. 42,660	Vandenburgh, J. Derek	Reg. No. 32,179
Hillson, Randall A.	Reg. No. 31,838	Wahl, John R.	Reg. No. 33,044
Holzer, Jr., Richard J.	Reg. No. 42,668	Weaver, Karrie G.	Reg. No. 43,245
Johnston, Scott W.	Reg. No. 39,721	Welter, Paul A.	Reg. No. 20,890
Kadievitch, Natalie D.	Reg. No. 34,196	Whipps, Brian	Reg. No. 43,261
Karjeker, Shaukat	Reg. No. 34,049	Whitaker, John E.	Reg. No. 42,222
Kastelic, Joseph M.	Reg. No. 37,160	Wickhem, J. Scot	Reg. No. 41,376
Kettelberger, Denise	Reg. No. 33,924	Williams, Douglas J.	Reg. No. 27,054
Keys, Jeramie J.	Reg. No. 42,724	Withers, James D.	Reg. No. 40,376
Knearl, Homer L.	Reg. No. 21,197	Witt, Jonelle	Reg. No. 41,980
Kowalchyk, Alan W.	Reg. No. 31,535	Wu, Tong	Reg. No. 43,361
Kowalchyk, Katherine M.	Reg. No. 36,848	Xu, Min S.	Reg. No. 39,536
Lacy, Paul E.	Reg. No. 38,946	Zeuli, Anthony R.	Reg. No. 45,255
Larson, James A.	Reg. No. 40,443		

I hereby authorize them to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/ organization who/which first sends/sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct Merchant & Gould P.C. to the contrary.

Please direct all correspondence in this case to Merchant & Gould P.C. at the address indicated below:

Merchant & Gould P.C.
P.O. Box 2903
Minneapolis, MN 55402-0903



I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

200	**Full Name Of Inventor**	**Family Name** Gioia	**First Given Name** Patrick	**Second Given Name**
201	**Residence & Citizenship**	**City** Rennes	**State or Foreign Country** Franee FRX	**Country of Citizenship** France
	Mailing Address	**Address** 32, rue Mirabeau 736 K	**City** Rennes	**State & Zip Code/Country** 35700 / France
Signature of Inventor 201:			**Date:** 02/02/02	

Attorney Docket No. 9320.116USWO

MERCHANT & GOULD P.C.

United States Patent Application

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: SELECTIVE MESH REFINEMENT

The specification of which
a. ☐ is attached hereto
b. ☒ was filed on as application serial no. and was amended on (if applicable) (in the case of a PCT-filed application) described and claimed in international no. PCT/FR99/01924 filed August 3, 1999 and as amended on (if any), which I have reviewed and for which I solicit a United States patent.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

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a. ☐ no such applications have been filed.
b. ☒ such applications have been filed as follows:

FOREIGN APPLICATION(S), IF ANY, CLAIMING PRIORITY UNDER 35 USC § 119			
COUNTRY	**APPLICATION NUMBER**	**DATE OF FILING (day, month, year)**	**DATE OF ISSUE (day, month, year)**
France	98 10097	August 3, 1998	
ALL FOREIGN APPLICATION(S), IF ANY, FILED BEFORE THE PRIORITY APPLICATION(S)			
COUNTRY	**APPLICATION NUMBER**	**DATE OF FILING (day, month, year)**	**DATE OF ISSUE (day, month, year)**

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U.S. APPLICATION NUMBER	DATE OF FILING (day, month, year)	STATUS (patented, pending, abandoned)

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U.S. PROVISIONAL APPLICATION NUMBER	DATE OF FILING (Day, Month, Year)

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(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

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(2) It refutes, or is inconsistent with, a position the applicant takes in:

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(ii) Asserting an argument of patentability.

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(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application:

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

(e) In any continuation-in-part application, the duty under this section includes the duty to disclose to the Office all information known to the person to be material to patentability, as defined in paragraph (b) of this section, which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

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Anderson, Gregg I.	Reg. No. 28,828
Batzli, Brian H.	Reg. No. 32,960
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Berns, John M.	Reg. No. 43,496
Black, Bruce E.	Reg. No. 41,622
Branch, John W.	Reg. No. 41,633
Bremer, Dennis C.	Reg. No. 40,528
Bruess, Steven C.	Reg. No. 34,130
Byrne, Linda M.	Reg. No. 32,404
Campbell, Keith	Reg. No.P-46,597
Carlson, Alan G.	Reg. No. 25,959
Caspers, Philip P.	Reg. No. 33,227
Chiapetta, James R.	Reg. No. 39,634
Clifford, John A.	Reg. No. 30,247
Coldren, Richard J	Reg. No 44,084
Daignault, Ronald A.	Reg. No. 25,968
Daley, Dennis R.	Reg. No. 34,994
Dalglish, Leslie E.	Reg. No. 40,579
Daulton, Julie R.	Reg. No. 36,414
DeVries Smith, Katherine M.	Reg. No. 42,157
DiPietro, Mark J.	Reg. No. 28,707
Edell, Robert T.	Reg. No. 20,187
Epp Ryan, Sandra	Reg. No. 39,667
Glance, Robert J.	Reg. No. 40,620
Goggin, Matthew J.	Reg. No. 44,125
Golla, Charles E.	Reg. No. 26,896
Gorman, Alan G.	Reg. No. 38,472
Gould, John D.	Reg. No. 18,223
Gregson, Richard	Reg. No. 41,804
Greseth, John J.	Reg. No. 33,112
Hamer, Samuel A.	Reg. No. 46,754
Hamre, Curtis B.	Reg. No. 29,165
Harrison, Kevin C.	Reg. No.P-46,759
Hertzberg, Brett A.	Reg. No. 42,660
Hillson, Randall A.	Reg. No. 31,838
Holzer, Jr., Richard J.	Reg. No. 42,668
Johnston, Scott W.	Reg. No. 39,721
Kadievitch, Natalie D.	Reg. No. 34,196
Karjeker, Shaukat	Reg. No. 34,049
Kastelic, Joseph M.	Reg. No. 37,160
Kettelberger, Denise	Reg. No. 33,924
Keys, Jeramie J.	Reg. No. 42,724
Knearl, Homer L.	Reg. No. 21,197
Kowalchyk, Alan W.	Reg. No. 31,535
Kowalchyk, Katherine M.	Reg. No. 36,848
Lacy, Paul E.	Reg. No. 38,946
Larson, James A.	Reg. No. 40,443
Leon, Andrew J.	Reg. No. 46,869
Leonard, Christopher J.	Reg. No. 41,940
Liepa, Mara E.	Reg. No. 40,066
Lindquist, Timothy A.	Reg. No. 40,701
Lycke, Lawrence E.	Reg. No. 38,540
Mayfield, Denise L.	Reg. No. 33,732
McDonald, Daniel W.	Reg. No. 32,044
McIntyre, Jr., William F.	Reg. No. 44,921
Mitchem, M. Todd	Reg. No. 40,731
Mueller, Douglas P.	Reg. No. 30,300
Nichols, A. Shane	Reg. No. 43,836
Pauly, Daniel M.	Reg. No. 40,123
Phillips, Bryan K.	Reg. No. P-46,990
Phillips, John B.	Reg. No. 37,206
Prendergast, Paul	Reg. No. 46,068
Pytel, Melissa J.	Reg. No. 41,512
Qualey, Terry	Reg. No. 25,148
Reich, John C.	Reg. No. 37,703
Reiland, Earl D.	Reg. No. 25,767
Samuels, Lisa A.	Reg. No. 43,080
Schmaltz, David G.	Reg. No. 39,828
Schuman, Mark D.	Reg. No. 31,197
Schumann, Michael D.	Reg. No. 30,422
Scull, Timothy B.	Reg. No. 42,137
Sebald, Gregory A.	Reg. No. 33,280
Skoog, Mark T.	Reg. No. 40,178
Spellman, Steven J.	Reg. No. 45,124
Stoll-DeBell, Kirstin L.	Reg. No. 43,164
Sumner, John P.	Reg. No. 29,114
Swenson, Erik G.	Reg. No. 45,147
Tellekson, David K.	Reg. No. 32,314
Trembath, Jon R.	Reg. No. 38,344
Tuchman, Ido	Reg. No. 45,924
Tunheim, Marcia A	Reg. No. 42,189
Underhill, Albert L.	Reg. No. 27,403
Vandenburgh, J. Derek	Reg. No. 32,179
Wahl, John R.	Reg. No. 33,044
Weaver, Karrie G.	Reg. No. 43,245
Welter, Paul A.	Reg. No. 20,890
Whipps, Brian	Reg. No. 43,261
Whitaker, John E.	Reg. No. 42,222
Wickhem, J. Scot	Reg. No. 41,376
Williams, Douglas J.	Reg. No. 27,054
Withers, James D.	Reg. No. 40,376
Witt, Jonelle	Reg. No. 41,980
Wu, Tong	Reg. No. 43,361
Xu, Min S.	Reg. No. 39,536
Zeuli, Anthony R.	Reg. No. 45,255

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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